Forest Renewal Section
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October 31, 1995

Regeneration Note 6

Mechanical Site Preparation for Vegetation Management in North-eastern British Columbia

Background

Site preparation plays a vital role in British Columbia's regeneration program. In the 1993/94 field season, over 166,000 hectares of forest land were site prepared in the province. Mechanical site preparation (MSP) accounted for 60%, or approximately 100,000 hectares.

Mechanical site preparation can have a significant effect on vegetation complexes. Consideration of these effects should be an integral part of all site preparation prescriptions.

Objectives

This regeneration note is limited to a detailed description of vegetation development on five treatments at one location, Inga Lake (Figure 1). Vegetation responses are discussed as they relate to three variables: plant community establishment, successional pathways, and phenology. Other treatments from the Inga Lake trial and general observations from the other trials will be drawn upon in the final discussion and conclusions.

FIGURE 1. Location of Inga Lake trial site.

Site Description

The Inga Lake trial is located in the Peace Moist Warm variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBS mw1). Soils are fine-textured and generally well drained. Trembling aspen (*Populus tremuloides*), Sitka alder (*Alnus crispa* ssp. *sinuata*) and various willows (*Salix* spp.), originating from wildfire in the mid-1950s, were sheared and windrowed in winter 1986/87.

Methods

Experimental Treatments

Site treatments, listed below, were undertaken in 1987 and the area was planted with white spruce (*Picea glauca*) in spring and summer, 1988.

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The following five treatments will be discussed in this paper.

Control

Winter sheared and piled in 1986/87; spring planted with boot screefing in 1988.

Burned windrows

The windrows formed by shearing and piling were burned in October 1987. The planting spots chosen were in well-burned areas with no residual slash present. The windrows were completely consumed and the forest floor under the windrows was significantly reduced.

Madge

The Madge Rotoclear formed a well-mixed layer of surface organic matter and mineral soil, about 15 cm deep (Figure 2). The 225-cm-wide drum turns at approximately 300 rpm, sufficiently fast to comminute the roots and above ground stems of the aspen and willow that had resprouted by the time the site was prepared on July 17, 1987. The entire area of the plot was prepared.

FIGURE 2. Mixing with use of the Madge Rotoclear in preparing the Inga Lake site.

Breaking plow

A three-bottom breaking plow, pulled by a D7 crawler tractor, created berms that were laid side by side. Generally, furrow slices were inverted so that the "upside-down" forest floor was directly on top of the mineral soil exposed by removal of the previous furrow slice (Figure 3). The entire area of the plot was prepared on September 23, 1987.

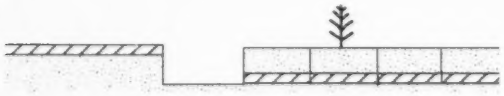


FIGURE 3. Berms laid side by side by breaking plow at the Inga Lake site.

Disc Trencher

A TTS Delta powered disc trencher created furrows and berms on September 23, 1987. Penetration was sufficient to give an appreciable mineral soil covering to the inverted LFH layers for most of the length of the berm. Seedlings were planted on the hinge (Figure 4).

FIGURE 4. Furrow and berm prepared by disc trencher.

Study Design and Statistical Analysis

Design

The Inga Lake study area was set up as a randomized block design with five blocks. Each block consisted of one 25 × 30 m rectangular plot or "mini stand" for each of the five treatments noted above. Forty-eight seedlings were planted in each plot for a total of 240 seedlings per treatment. Each tree was measured in the fall for height and diameter.

Vegetation was assessed in July/August using seedling centred 1.0 m radius circles established on ten seedlings per plot for a total of 50 samples per treatment. Vegetative cover (visually estimated), average height and dominant species were recorded for each sample. In addition, the distance from the seedling to the nearest vegetation was recorded.

Statistical Analysis

Analysis of variance (ANOVA) was used to analyze seedling height and diameter measurements using Statistical Analysis Systems (SAS). Differences among treatment means were evaluated with Duncan's Multiple Range Test.

A competition index (CI) was calculated for each treatment using the following formula:

$$\frac{\text{mean vegetation height} \times \text{mean vegetation per cent cover}}{\text{mean distance to nearest seedling}}$$

Results and Discussion

Plant Community Establishment and Successional Pathways

Control

Vegetation development on the control was rapid and extensive. By the end of 1988, the average height of vegetation was 38 cm and 70% of the ground was covered

by vegetation. After five growing seasons (1992), the average vegetation height was 144 cm and the ground cover was 85%.

The competitive index (Figure 5), decreased somewhat in 1990 due to a leaf miner attack on the willows (Scouler's willow [*Salix scouleriana*], Bebb's willow [*S. bebbiana*] and pussy willow [*S. discolor*]), then increased significantly in 1991 and 1992.

One year after shearing, aspen, willow and alder were well established on the site. The grasses, fuzzy-spiked wildrye (*Elymus innovatus*), blue wildrye (*E. glaucus*) and bluejoint (*Calamagrostis canadensis*) were also quite common. Over time, willow, alder and aspen became more dominant at the expense of grass. By year five, the dominant species on site were similar to those present prior to treatment.

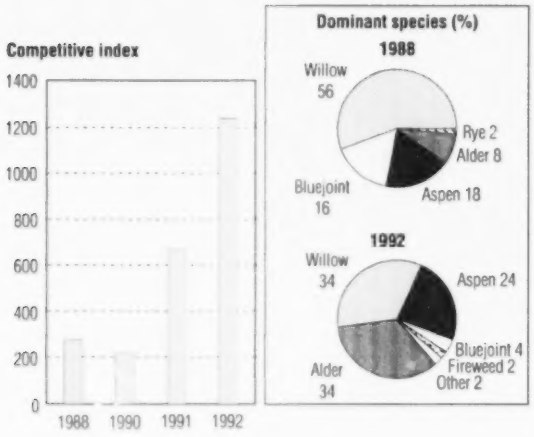


FIGURE 5. The competitive index and dominant species under control treatment at Inga Lake from 1988 to 1992.

Burned – windrows

The fire was sufficiently intense to eliminate the three dominant pre-treatment species: willow, aspen and alder. The competitive index remained low throughout the term of the trial (Figure 6). By 1992, the average vegetation height was 42 cm and the ground cover was only 31%.

In 1988, the fire-treated site was dominated by Bicknell's geranium (*Geranium bicknellii*) and fireweed (*Epilobium angustifolium*). The geranium proved to be ephemeral and was almost completely absent by 1989. The decrease in geranium accounts for the lower competitive index in 1990 (Figure 6).

By year five, the vegetation complex included a broader mix of dominant species but early seral species such as fireweed, horsetail (*Equisetum* spp.) and bluejoint still dominated.

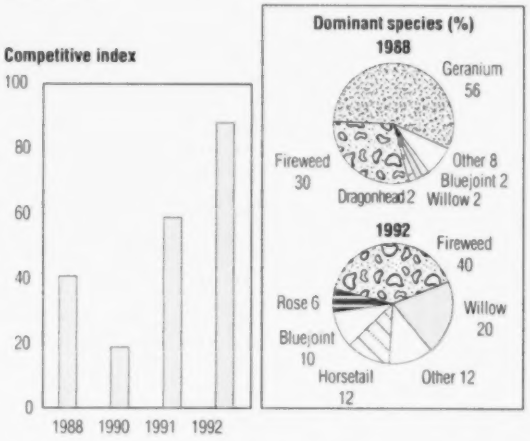


FIGURE 6. The competitive index and dominant species under treatment with burned / windrow at Inga Lake from 1988 to 1992.

Breaking Plow

Vegetation development on the breaking plow site was relatively low from 1988 to 1990, but increased significantly in 1991 (Figure 7). By 1992, the average vegetation height was 69 cm and the ground cover was 60%. The spruce seedlings were well established and thrifty. Vegetation was not visibly affecting seedling performance. However, if shrub development continues at the present rate, seedling performance may be compromised in the future.

In 1988, the breaking plow treated site was dominated by fireweed. Over time, the number of dominant species increased (e.g., species such as rose [*Rosa acicularis*], willow and alder). By year five there was a broad range of dominant species.

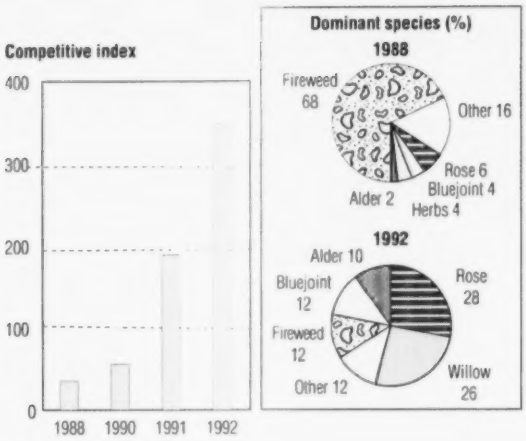


FIGURE 7. The competitive index and dominant species under treatment with breaking plow at Inga Lake from 1988 to 1992.

Madge

Vegetation development on the Madge-treated site was minimal in 1988 and remained relatively low throughout the duration of the trial (Figure 8). While ground cover increased to 74% after five growing seasons (1992), average vegetation height was only 38 cm. It is not anticipated that vegetation will seriously compromise future seedling performance.

In 1988, the Madge treatment was dominated by fireweed, herbs and forbs. Shrubs were only evident on small untreated strips where passes made by the Madge had not overlapped. By 1992, bluejoint had replaced fireweed as the most dominant species. Shrubs were increasing but were still relatively insignificant.

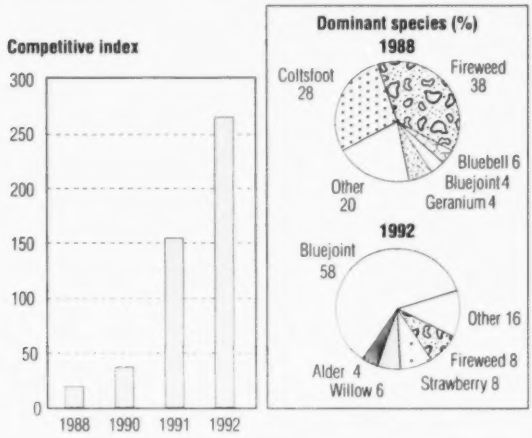


FIGURE 8. The competitive index and dominant species under treatment with the Madge Rotoclear at Inga Lake from 1988 to 1992.

Disc Trencher

Vegetation development on the disc trencher was similar to the control (i.e., by year five it was dominated by dense willow, alder, and aspen). For simplicity, specific information is not included in this paper.

The four detailed examples given above illustrate how vegetation complexes changed when an ecosystem was constant but treatment types varied. Results showed that if the treatment type, treatment intensity and ecosystem were consistent, the type of plant community that developed approximately one year after site preparation was quite predictable. It was also found that the development of seral vegetation to the end of the fifth growing season (1992) was also reasonably predictable (Figures 5 to 9).

Preliminary observations also indicate that if the treatment is constant and the ecosystem is varied, the resulting vegetation complex will vary in a reasonably predictable manner. For example, five years after treatment, is was generally observed that for drier areas (submesic to mesic) treated with the Madge, there was less total vegetation on the site but a greater number of dominant species (e.g. bluejoint, rose, fireweed, and clover). In contrast, on wetter sites, vegetation was more dense and dominated by bluejoint.

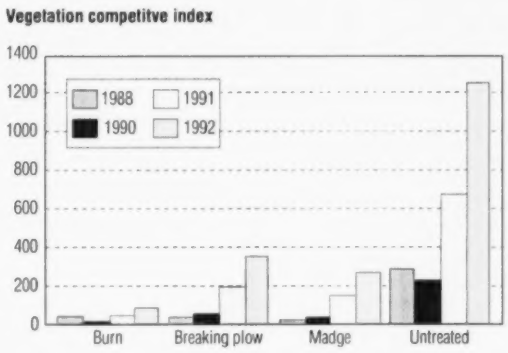


FIGURE 9. The competitive index and dominant species at Inga Lake under varied mechanical site preparation treatments from 1988 to 1992.

In summary, it was found that for plant community establishment and successional pathways, a common ecosystem treated with different types of MSP leads to very different, but reasonably predictable vegetative complexes.

Phenology

It is important for forest managers to understand what vegetation complex will develop on a site following MSP and how this complex will progress over several years. It is also important to understand how the different vegetation complexes develop during the course of a season and how this development affects seedling performance.

A pilot study in which vegetation and seedling development were monitored biweekly was initiated in 1991. More intensive monitoring occurred in 1992 and in 1993. This regeneration note introduces the preliminary data collected in 1991. A subsequent regeneration note will deal with vegetation dynamics over the three-year period.

Different vegetation communities develop differently over a growing season and consequently their effects on seedling growth also differ. For example, on this site seedlings growing in the willow-aspen-alder complex (control) were overtopped prior to the growing season. Early development of foliage in the spring led to immediate and dense overtopping. In contrast, the grass-dominated complex (Madge) developed from the ground up and did not overtop seedlings until later in the season (Figure 10a).

A similar observation was noted in New Brunswick, where it was found that woody competitors were more detrimental to seedling growth than herbaceous competitors; the herbaceous competitors allowed more direct sunlight early in the growing season, when they were developing from the ground up.

It is interesting to note that, at Inga Lake, seedling height increment was lower for the control and peaked earlier in the season than with the other treatments (Figure 10b).

As vegetation communities develop, seedlings may be exposed to various forms of stress that relate directly to the stage of development of the vegetation on site. For example, research has shown that tall vegetation may act as a nurse crop, protecting seedlings from frost damage. In contrast, it has been shown that short grass, where the top of the seedling is near the upper surface of the grass, may lead to increased frost damage. It must be noted that a grass species such as bluejoint grows from the ground up each year, so will affect a seedling differently at different times in the growing season. In 1991, at Inga Lake, bluejoint approached the average seedling height relatively early in the season, hence the risk of spring frost damage increased. As noted earlier, percent cover of bluejoint increased significantly on areas treated by the Madge, with the result that seedlings planted on the Madge-treated areas were susceptible to spring frost damage in 1991 (Figure 11).

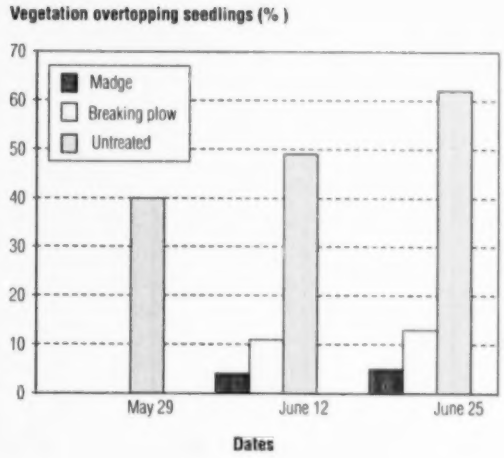


FIGURE 10a. Percent average vegetation cover overtopping seedlings between May 15 and June 25, 1991 at Inga Lake under varied site preparation treatments.

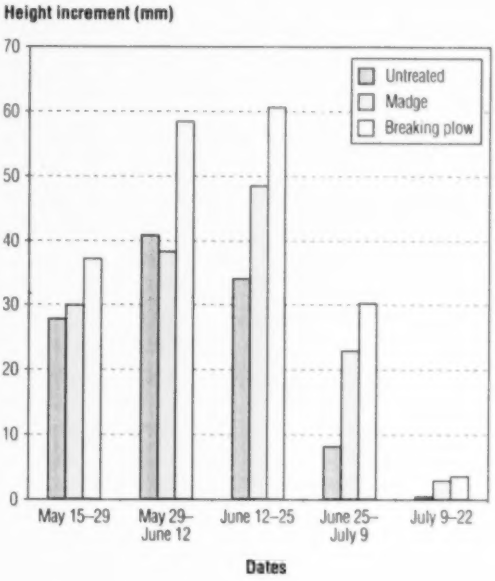


FIGURE 10b. Progressive seedling height growth between May 15 and July 22, 1991 at Inga Lake under varied site preparation treatments.

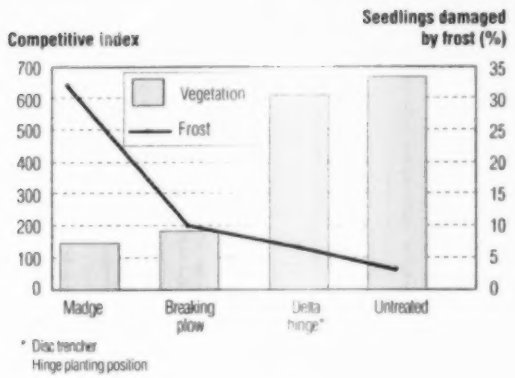
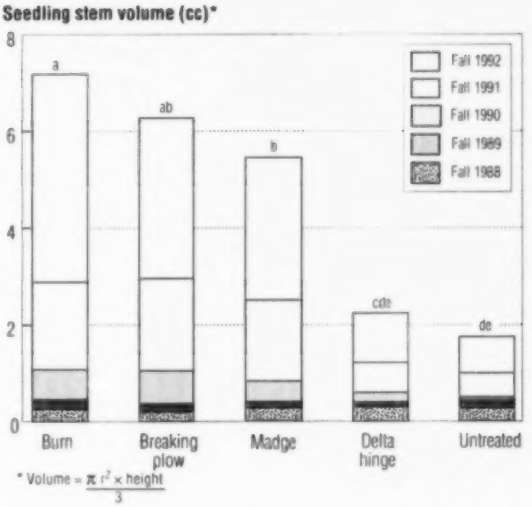


FIGURE 11. Frost damage related to vegetation cover at Inga Lake between May 29 and June 12, 1991.



Values for each growth measurement followed by the same letter were not significantly different at $\alpha = 0.05$. (Letters apply to Fall 1992 only.)

FIGURE 12. On the Inga Lake site, vegetation plays a leading role in determining seedling performance.

Predicting Vegetation Response

As noted above, mechanical site preparation treatments lead to somewhat predictable vegetation responses. These vegetation responses have important management implications. Some of these implications are noted below:

- Vegetation affects seedlings directly and indirectly and can significantly affect overall seedling performance (Figure 12). While not all of the variation in seedling performance illustrated in Figure 12 can be directly attributed to vegetation, on this site vegetation plays a leading role in determining seedling performance.
- Vegetation cover may significantly affect the degree of seedling damage caused by rodents (Figure 13). At Inga Lake, treatment areas with a high vegetation index provided cover for rabbits, and in turn suffered increased rabbit damage. It is interesting to note that the highest level of damage occurred on the disc trencher treatments. The vegetation on this treatment was sufficient to provide shelter for the rabbits and the furrows provided passageways that directed the rabbits to the seedlings.
- Knowledge of vegetation phenology is useful in determining the most appropriate time to treat a site. For example, if an MSP treatment that exposes mineral soil is used and fireweed is seen to be a major competitor on the site, treating the site in late summer (when fireweed is casting its seed) could lead to increased vegetative competition. Under these circumstances, a late summer treatment would have the seed being cast into a very receptive seedbed and probably germinating aggressively the following spring.

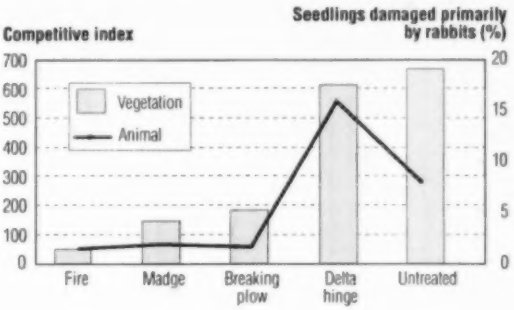


FIGURE 13. At Inga Lake, treatment areas with a high vegetation index provided cover for rabbits and suffered increased rabbit damage.

- An understanding of seral development is also important for determining follow-up treatments. For example, it was noted earlier that the first year after a site similar to Inga Lake is treated with the breaking plow, it will be invaded quickly by fireweed. Over time, however, the vegetation complex will change to include bluejoint and a number of other species. However, if the plowed area is treated with herbicide when it is in an early seral state (i.e., dominated by fireweed), the fireweed will be virtually eliminated from the site and the vegetation will shift directly to a complex dominated by bluejoint.

- Knowledge of vegetation succession may be used to develop treatments that provide forage for animal species (e.g., moose move into the Inga Lake site in the fall and heavily browse the willow). In one trial located in the southern United States, vegetation following MSP has been carefully monitored to see which treatment type provides the most favourable vegetation complex for a range of wildlife species.
- Different seral pathways may affect long-term site productivity. For example, what are the long-term implications for a site that includes a grass complex as part of its development (for example, a site treated with a Madge Rotoclear rather than burned windrows)? More information is required before this question can be properly answered.

Conclusion

In this study we found that specific mechanical site preparation treatments on specific ecosystems lead to somewhat predictable vegetation responses. Understanding and predicting these responses has important implications for management and should be considered in determining site preparation prescriptions. Further research is required on a broader range of ecosystems, to allow accurate prediction of seral vegetation sequences on a wide range of sites. Continued research is also required to determine the role different seral pathways play in determining long-term site productivity.

Acknowledgements

The authors wish to thank Marvin Grismer for collecting much of the field data upon which this report is based, and Linda Stordeur for statistical analysis.

Information contained in this regeneration note is reprinted from a paper prepared by Lorne Bedford Silviculture Practices Branch, and Andy MacKinnon, Research Branch, presented at the Integrated Vegetation Management: Options and Applications Workshop, Richmond, B.C., November 1993.

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